

Phys11 Heat Transfer : Notes/W.S.-55

There are three ways in which heat energy is transferred; **conduction**, **convection**, and **radiation**.

Conduction

Heat can be transferred from one end of a body (such as a metal rod), to the other end, by heating the first end. This causes atoms in the heated end to move faster causing more vigorous collisions with neighboring atoms (see the kinetic theory of matter). The energy of the neighboring atoms increases. This transfer of kinetic energy by collisions is the heat that moves down the rod. In this way, heat is said to be conducted down the rod. **Conduction** is defined as : "The transmission of heat by collisions between atoms or molecules".

Metals are the best heat conductors. Of the metals, silver is the best conductor, followed by copper and iron. It is interesting to note that the best conductors of heat are also the best conductors of electricity. Poor heat conductors are called **insulators**. Wood and styrofoam are good insulators. Also, gases and liquids are generally, poor heat conductors.

Convection

In **convection**, a hot liquid or gas moves from one region to another, taking heat energy with it. This flow of heat is called a convection current. This is how central heating works. Air is heated and moved by a fan to a region of cooler air. Or, natural convection occurs as hot air rises and displaces cooler air which moves downward and is reheated.

Radiation

The third mechanism of heat flow is radiation. Objects will cool down even if they are not touching another object or are in a vacuum. The energy is radiated as electromagnetic waves (usually infrared).

Problems : Use the concepts of conduction, convection and radiation, to explain the following.

- 1) Explain why a block of metal feels cooler than a similar block of wood. Assume both are initially at room temperature.

- 2) A thermos bottle has an evacuated space inside for "insulation". It also has a silver coating inside. Explain how it can keep tea hot for several hours.

- 3) Houses are best insulated using fiberglass. (it is mostly air) Explain.

- 4) If you put two spoons, one silver and one copper, into a cup of boiling water, which will get hot faster? Why?

- 5) The "Space Blanket" is a piece of thin plastic coated with aluminum. It can save your life in an emergency. You wrap it around yourself when cold. Explain how it works.

- 6) Hot coffee is sold in styrofoam cups. Why?

- 7) When you sit in front of a fireplace, your face feels warm. If you cover your face, it cools down. Explain.

- 8) Astronauts keep warm in their space suits. There are several layers of aluminum coated plastic in the suit. Explain how the suit works.

- 9) Why does a fur coat keep you warm in the winter?

- 10) Explain how the sun heats objects on Earth.

Answers : 1) Metal is a better conductor. Heat leaves the hand more readily so the hand feels cooler., 2) In a thermos bottle, there is very little conductivity, convection, or radiation. A vacuum is a poor conductor, there is no convection, and the silvered surface reflects

heat radiation back., 3) Fiberglass has a lot of "dead" air. That is, air that cannot move. Air is a poor conductor. Also, there is very little convection. Some fiberglass bats have a foil backing which is placed on the inside to reflect radiant heat inward., 4) Silver., It is a better heat conductor., 5) It reflects the radiant heat of the body back., 6) Styrofoam is a poor heat conductor. Your hand won't get hot., 7) The fire heats the face by radiant energy which can be blocked by the hand. The fire also keeps the room warm by convection., 8) The body heat (infrared radiation) is reflected back., 9) The fur has dead air which is a poor conductor., 10) The Sun's energy is transferred to Earth as radiant energy (electromagnetic waves).